1653
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UNIVERSAL PORTLAND CEMENT

UNIVERSAL PORTLAND CEMENT COMPANY
UNIVERSAL
PORTLAND
CEMENT
CHICAGO - PITTSBURG

**UNIVERSAL
PORTLAND CEMENT CO.
CHICAGO - PITTSBURG**

1653
13

UNIVERSAL PORTLAND CEMENT COMPANY

UNIVERSAL

PORTLAND CEMENT

CHICAGO - PITTSBURG

A STANDARD PORTLAND
FOR UNIVERSAL USE

UNIVERSAL is strictly a true Portland cement, being made from slag and limestone burnt to a hard clinker in rotary kilns, and is entirely free from sulphides. It has no points of similarity with Puzzolan or so-called "slag cements" which are merely mechanical mixtures of slag and slacked lime and are suitable only for use underground in moist locations.

As its name implies, Universal Portland Cement is suitable for all classes of work above or below ground, including sidewalks and reinforced concrete work under all possible conditions.

UNIVERSAL PORTLAND CEMENT

A STANDARD PORTLAND FOR UNIVERSAL USE

DAILY OUTPUT 17,000 BARRELS
PLANTS AT CHICAGO AND PITTSBURG

UNIVERSAL PORTLAND CEMENT CO

CHICAGO — PITTSBURG

January First, Nineteen Hundred and Eight

PRODUCTION OF

UNIVERSAL PORTLAND CEMENT

BY YEARS

1900-1908

	Barrels
1900	32,443
1901	164,316
1902	318,710
1903	462,930
1904	473,294
1905	1,735,343
1906	2,076,000
1907	2,300,000
1908 (Estimated)	6,000,000

LIBRARY of
THE
FRANKLIN
INSTITUTE

PLANTS

PLANT No. 2. Daily output, 1500 barrels, South Chicago, Illinois, on C., L. S. & E. Railway, connecting with all roads out of Chicago.

PLANT No. 3. Daily output, 5000 barrels, Buffington, Indiana, on C., L. S. & E. Railway, connecting with all roads out of Chicago.

PLANT No. 4. Daily output, 6000 barrels, Buffington, Indiana.

PLANT No. 5. Daily output, 4500 barrels, Universal, Pennsylvania, (Pittsburg), on Union Railroad, connecting with all roads out of Pittsburg.

OFFICES

GENERAL OFFICES . . . Commercial Bank Building
Chicago, Illinois

PITTSBURG OFFICE . . . . . 524 Frick Building
Pittsburg, Pennsylvania

MINNEAPOLIS OFFICE . 836 Security Bank Building
Minneapolis, Minnesota

ST. LOUIS OFFICE . . . 815 Chemical Building
St. Louis, Missouri

D 88-134550. TCF

Office and Laboratory Building at Plants Nos. 3 and 4, Buffington, Ind. Universal Portland Cement Co.

THIS building is constructed entirely of Universal Portland Cement and is one of the finest examples of the possibilities of artificial stone construction. The exterior is built of cast cement stone, the interior columns, beams, stairways, floors and roof being of reinforced concrete, and the partitions of hollow concrete blocks.

UNIVERSAL PORTLAND CEMENT was first placed on the market in May, 1900. Since that time the demand has been so great as to necessitate continual enlargement of capacity, the shipments in 1906 exceeding 2,000,000 barrels, an output greater than the entire production of the United States in the year 1896.

During the past year, two new mills have been completed and are now in operation, Plant No. 4 at Buffington, Indiana, with a capacity of 6000 barrels a day, and Plant No. 5 at Universal, Pennsylvania, near Pittsburg, with a capacity of 4500 barrels a day. The combined output of the Company is now 17,000 barrels a day of Universal Portland Cement. This output of 6,000,000 barrels per annum will considerably exceed ten per cent of the production of the entire United States.

This rapid growth is due to the high quality of the product and its remarkable uniformity, combined with the excellent service given in the matter of prompt shipments and strict compliance with all agreements. The motto "A Contract is a Contract," is strictly observed in all cases.

The cement manufactured in the new mills, as well as the old, is made from the same raw materials, by the same special process and under the same supervision which have been so successfully employed since May, 1900.

The Universal Portland Cement Company is a subsidiary of the United States Steel Corporation. Uniform slag of the proper character is obtained from other Steel Corporation companies; in the case of the Chicago plants, from the Illinois Steel Company, and for the Pittsburg plant, from the Carnegie Steel Company. Both these steel companies use ore from the same Lake Superior ore mines, and the resulting slag is identical in its character, the limestone used in each case being pure calcite. We therefore have exactly the same raw materials, although the locations of our plants are a long distance apart. In this we differ from cement companies producing cement from natural deposits, which vary greatly in different parts of the country.

The constant use of Universal Portland Cement for the last eight years in all classes of work, such as sidewalks, floors, artificial stone, reinforced concrete, general engineering work, foundations, piers, dams, fireproofing and general building construction, has given it a splendid reputation as a standard Portland of the highest quality.

The accompanying illustrations show some of the classes of work in which Universal has been used by the most prominent architects, engineers, railroads and various departments of the United States Government. There is no class of work requiring the use of Portland cement where Universal has not been successfully used.

The methods of inspection during manufacture and of the finished product are so rigid that it is impossible for any Universal to be shipped that is not of proper quality in every respect. It will easily meet all usual and proper tests, including the standard specifications for Portland cement as adopted by the American Society for Testing Materials, or the specifications of the Corps of Engineers of the United States Government. These specifications are given in the back of this catalogue.

The Chicago plants are reached by all railroad lines running out of Chicago, and the Pittsburg plant is located on the Union Railroad, through which connection is made with all railroad lines entering Pittsburg. In addition to these railroad facilities, we are able to reach all points on the Great Lakes by water.

The combination of immense output, ample stock of seasoned cement on hand at all times and unexcelled shipping facilities, permits of most satisfactory service in the matter of prompt shipments.

Universal Portland Cement is guaranteed to be fully equal for all classes of work to any other Portland cement manufactured in this country or abroad.

PROCESS OF MANUFACTURE

Fig. 1

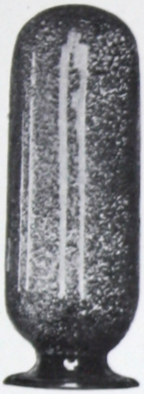


Fig. 2.

Fig. 3

Fig. 4

Figures 1 and 2 show the two raw materials, crushed limestone and chilled blast furnace slag, used in the manufacture of Universal Portland Cement.

These are thoroughly ground together in proper proportions, then burned to a clinker in rotary kilns. This clinker (Figure 3) is afterwards finely ground, and the resulting product (Figure 4) is a true Portland cement, its method of manufacture, chemical composition and specific gravity being strictly in accordance with the definitions of the most prominent cement authorities in the United States and Europe.

True Portland cement made from slag should not be confused with Puzzolan or so-called "slag cements," which are simply mechanical mixtures of slag and slacked lime ground together without burning, the latter being suitable only for use underground or in moist locations.

Following is analysis of Universal Portland Cement by Robert W. Hunt & Co., Chicago, December 26, 1900:

		Per Cent.
Silica	SiO_2	23.62
Alumina	Al_2O_3	8.21
Oxide of Iron	Fe_2O_3	2.71
Lime	CaO	61.92
Magnesia	MgO	1.78
Sulphuric Anhydride	SO_3	1.32
Sulphur as Sulphides		None
Loss on Ignition		0.52

(Signed) ROBERT W. HUNT & CO.

New South Bridge, Jackson Park, Chicago

P. J. Weber, Architect, Chicago T. E. Hill & Co., Contractors, Chicago

Universal Portland Cement used exclusively — 3000 barrels

Music Court Bridge, Jackson Park, Chicago

Block Bridge & Culvert Co., Contractors, Indianapolis

Reinforced concrete arches veneered with rough granite

Universal Portland Cement used exclusively—1300 barrels

Double Track Concrete Bridge

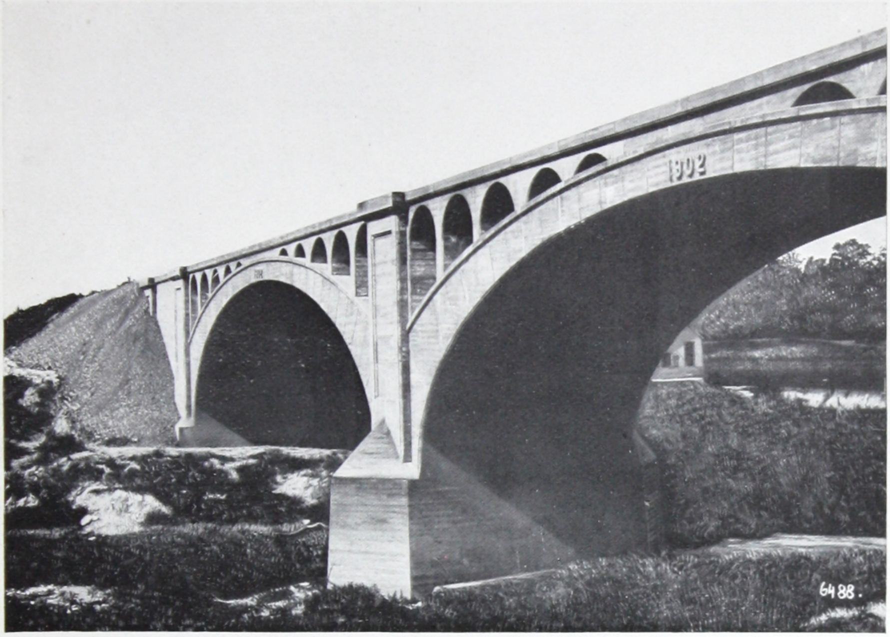
On Illinois Central Railroad north of Laclede, Illinois. Arch, 86-foot span
Universal Portland Cement used exclusively in this structure

Double Track Two-arch Concrete Bridge

On Illinois Central Railroad north of Bois, Illinois. Arches, 40-foot span
Universal Portland Cement used exclusively in this structure

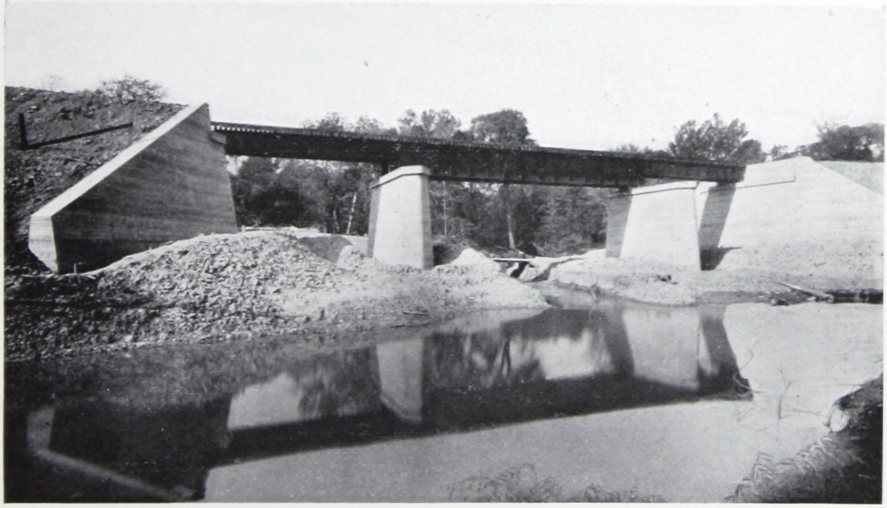
Double Track Concrete Bridge

On the Illinois Central Railroad near Watson, Illinois. Arches, 124-foot span
4000 barrels of Universal Portland Cement used in this structure



Double Track Concrete Bridge

On the Illinois Central Railroad near Watson, Illinois. 4000 barrels Universal Portland Cement used in this structure



Piers and Abutments for Double Track Bridge

On Chicago & Eastern Illinois Railroad at Woodland, Illinois
Universal Portland Cement used

Two Views of Reinforced Concrete Bridge on Big Four Railway at Avon Near Indianapolis, Indiana

W. M. Duane, Chief Engineer

Savage Construction Co., Contractors

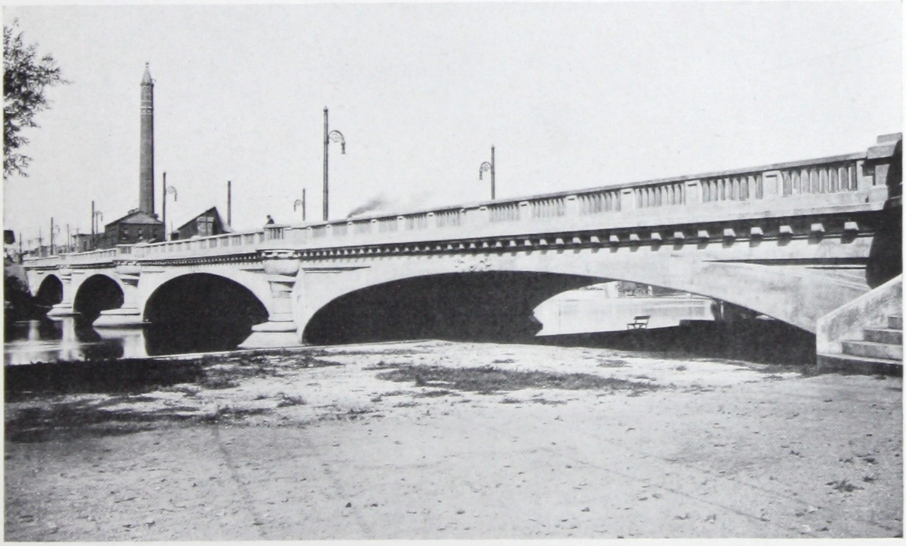
Spans 75 feet clear

Universal Portland Cement used—8000 barrels

Alton Granite and St. Louis Traction Co. Bridge at Mitchell, Illinois

J. G. White & Co., Contractors

Universal Portland Cement used — 1200 barrels



Jefferson Street Bridge, South Bend, Indiana

A. J. Hammond, Engineer, South Bend, Indiana James O. Heyworth, Contractor, Chicago

Universal Portland Cement used exclusively — 14,000 barrels. Melan Reinforcement

For full description, see *Engineering News*, June 21, 1906

Bridge at Eau Claire, Wisconsin

Universal Portland Cement used — 6000 barrels

McCLELLAN DODGE,
CIVIL ENGINEER

CITY CIVIL ENGINEER

SURVEYS, PLANS, SPECIFICATIONS AND R
PAVING, WATER WORKS, SEWERAGE SYS
AND SEWAGE DISPOSAL WORKS,
WATER POWER DEVELOPEMENT

EAU CLAIRE, WIS., 4/2/06

Illinois Steel Company,
Chicago, Ill.

Dear Sirs:-

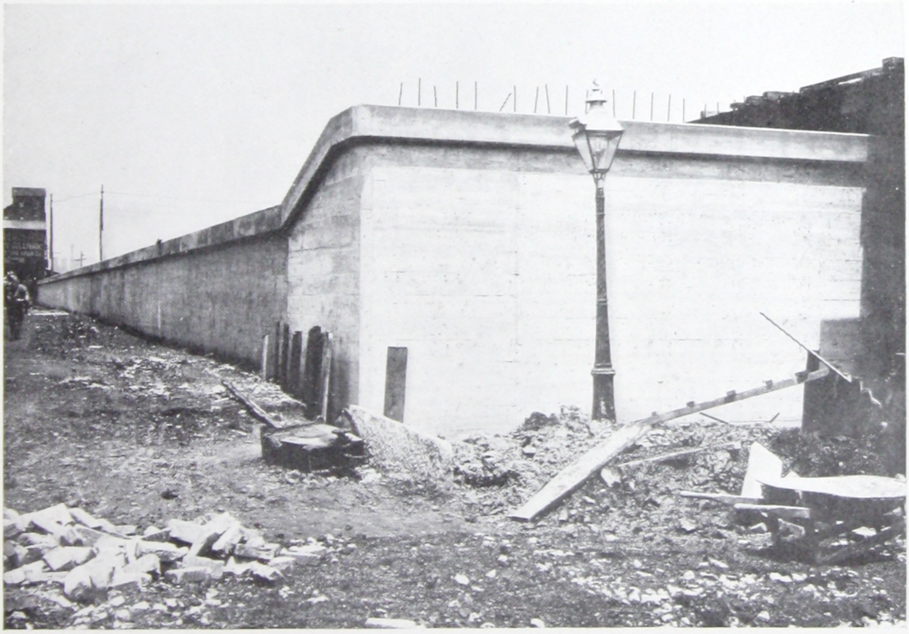
Replying to your favor of the 30th. ult., I have the pleasure of supplying you the following information relative to the Barstow Street bridge in which your cement was used throughout.

The bridge is built on a skew of 77 degrees; consists of two true semi-elliptical arches having clear spans of 82 feet and rise at center of arches of 14½ feet from springing line; length out to out of abutments 234 feet; foundation, sand, gravel and piles of which latter over 600 were used; thickness of pier at springing line, 10 feet; thickness of arches at center 20 inches; reinforcement, Johnson Bars; pavement, brick on concrete base six inches thick; walks, two 10 feet in the clear width; width over all 66 feet; contract price, $37,067.00; contractor, George Nelson, Madison, Wis., engineer, designing and constructing, McClellan Dodge, Eau Claire, Wis.

I trust I may be favored with a copy of the publication when issued and if I can be of further service I will be glad to serve you.

Very truly yours

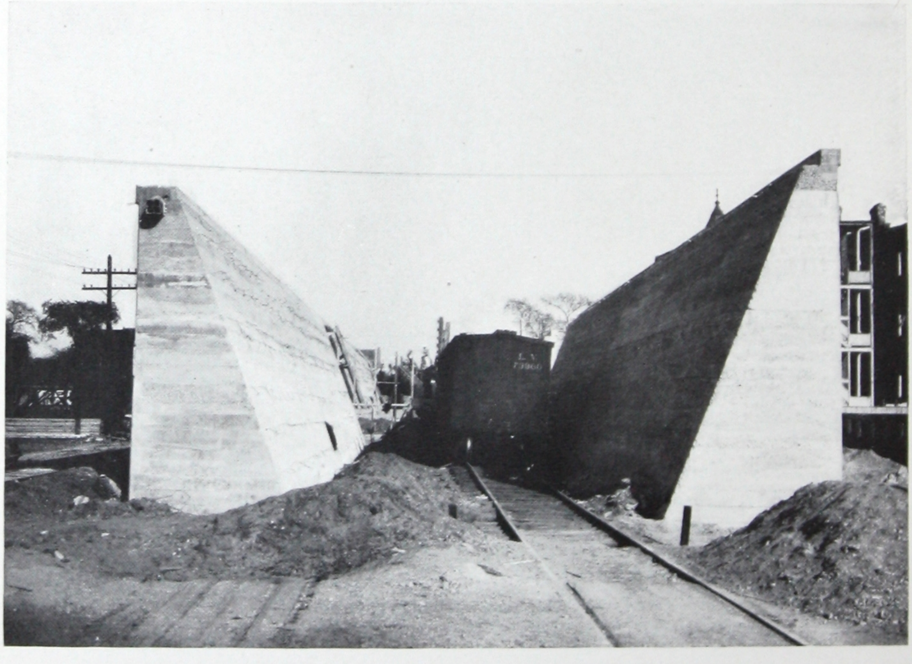
McClellan Dodge



Chicago & Western Indiana R. R. Track Elevation

E. H. Lee, Chief Engineer M. K. Trumbull, Assistant Engineer

Universal Portland Cement used — 90,000 barrels



Chicago Junction Railway Track Elevation

J. B. Cox, Chief Engineer   O. F. Cole, Principal Assistant Engineer   James O. Heyworth, Contractor

Universal Portland Cement used — 130,000 barrels

Reservoir at Bloomington, Illinois
Universal Portland Cement used — 5600 barrels

WM. A. SWORDS JAMES W. JORDAN M. E. CASE WALLACE C. EVANS, MGR. CIVIL ENGINEER.

CRESCENT STONE COMPANY
(CO-PARTNERSHIP)

MUNICIPAL CONTRACTORS

DEALERS IN
CRUSHED STONE
WASHED SAND AND GRAVEL

103 Y M C. A. BUILDING

PHONE MAIN 3566.

PEORIA, ILL. March 28, 1906.

Illinois Steel Co.,
"The Rookery",
Chicago, Ill.

Gentlemen;

In reference to the cement which we purchased from you last year that was used in the new reservoir at Bloomington, Ill., and some street work, will say that Mr. Folsom, City Engineer of Bloomington, reports all tests which he made were above the standard required by said City. He also reported that the cement did not vary to any extent, that is if a 24 hour test showed 200 pounds from any particular car, in all the other cars it did not vary but a pound or two from the 200. All of the cement was acceptable to the Engineer.

The shipment of the 5,000 or 6,000 barrels which we used was entirely satisfactory to us as our work was not delayed at all from the lack of cement.

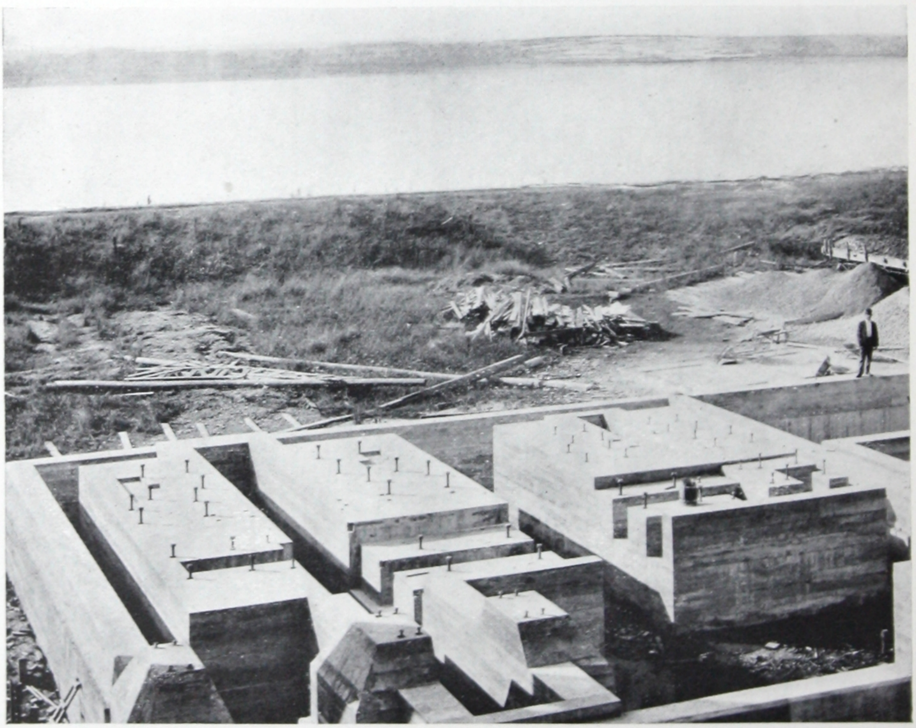
Up to date, the work is in good condition and we can see no reason why it should not prove entirely satisfactory. We have never been treated better in all respects considering the prompt delivery, quality of material and final adjustment, in the fulfillment of our order for the above cement.

Yours truly,
Crescent Stone Co.,
Per W C Evans Mgr.

R.S.

For complete description, see *Engineering Record*, March 3, 1906, vol. 53, No. 9, p. 285

Pettibone-Mulliken Plant, Chicago
Jacob Rodatz, Contractor, Chicago
Universal Portland Cement used exclusively

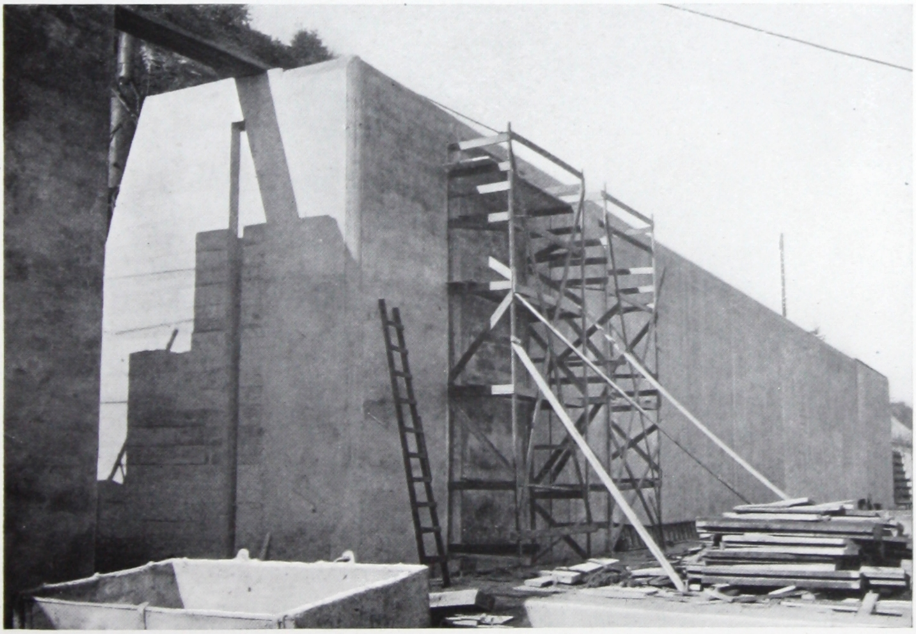


Foundations Illinois Central Elevator, New Orleans
Geo. B. Swift Co., Contractors, Chicago
Universal Portland Cement used exclusively

Fairbanks Co's Warehouse, New Orleans, La.

Stone Brothers, Architects — Cook & Laurie, Ltd., Contractors

Universal Portland Cement used exclusively in building and sidewalks—3500 barrels



Concrete Lock, Mississippi River, between St. Paul and Minneapolis

Being constructed under Engineer Corps, U. S. A.

Universal Portland Cement used—8000 barrels

Concrete Blocks

Made of Universal Portland Cement at Milwaukee, Wis.

First Presbyterian Church, Toledo, Iowa

Universal Portland Cement — 600 barrels used in concrete blocks

First National Bank Building, Monroe and Dearborn Streets, Chicago

D. H. Burnham & Co., Architects, Chicago John Griffiths & Son, Contractors

Universal Portland Cement used in this building—8000 barrels

Railway Exchange Building, Chicago

D. H. Burnham & Co., Architects

THIS 17-story 200 x 168 foot building, recently completed, at the corner of Jackson and Michigan Boulevards, costing a little less than $2,000,000, rests on foundations consisting of 52 cylindrical concrete piers, from 6 feet to 8 feet in diameter, extending down to bed rock, about 90 feet below the street level. Universal Portland Cement was used exclusively in these foundations. Quantity, 8000 barrels.

Rector Building, Chicago

Jarvis Hunt, Architect — Geo. A. Fuller Co., Contractors

Universal Portland Cement used—4000 barrels

American Trust Building, Chicago

Jarvis Hunt, Architect — Geo. A. Fuller Co., Contractors

Universal Portland Cement used—7000 barrels

Republic Building, Chicago

Holabird & Roche, Architects — Wells Bros. Co., Contractors

Universal Portland Cement used exclusively—8000 barrels

Wabash Passenger Station, Pittsburg, Pa.

Theo. C. Link, Architect, St. Louis — Geo. A. Fuller Co., Contractors

Universal Portland Cement used — 8000 barrels

Montgomery Ward & Company's New Building, Chicago, Illinois

Richard E. Schmidt, Garden & Martin, Architects

Geo. A. Fuller Co., Contractors

About 80,000 barrels Universal Portland Cement used

THE building covers 140,000 square feet, or approximately 3¼ acres. It has eight stories and a basement.

The foundations are piles, with reinforced concrete caps. All columns, exterior walls, several of the interior walls, girders, floors, stairs and roof are of reinforced concrete. The dock is also of reinforced concrete.

The first floor contains four tracks with spacing for forty freight cars. The various floors will be divided into seven sections of about equal areas, separated by fireproof walls, and fire doors. The stairs and elevators are enclosed in shafts of concrete construction.

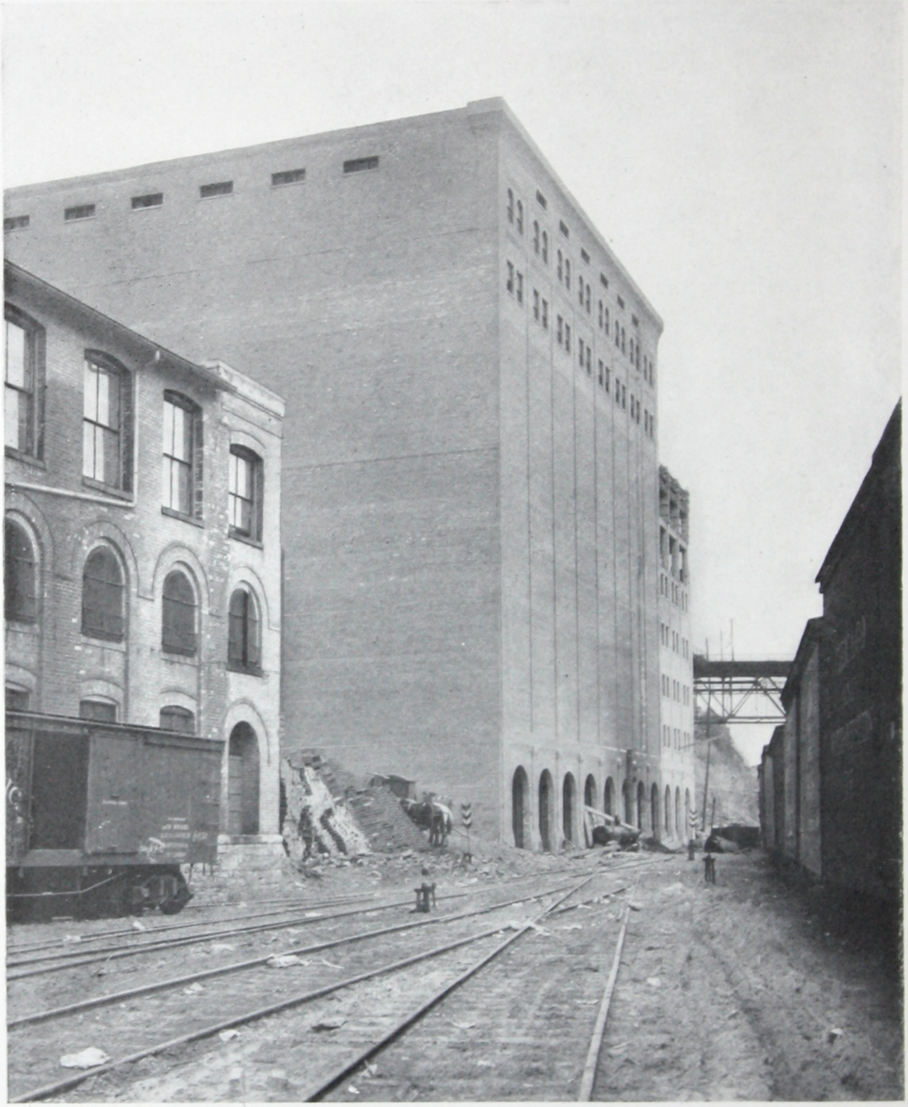
There is an expansion joint at each dividing wall. The columns are reinforced with spiral hooping and square twisted and round rods are used in the girders and floors.

THIS IS THE LARGEST REINFORCED CONCRETE STRUCTURE IN THE WORLD

St. Louis Star Building

Barnett, Haynes & Barnett and E. C. Helfensteller, Associate Architects
Roebling Construction Company, Contractors

Universal Portland Cement used exclusively in concrete fireproofing
Quantity, 3000 barrels



A. Booth & Co. Cold Storage Warehouse, St. Paul, Minn.

Butler Brothers, Contractors, St. Paul, Minn.

Reinforced Concrete throughout, Brayton System
Universal Portland Cement used exclusively

Stock Exchange Building, New Orleans

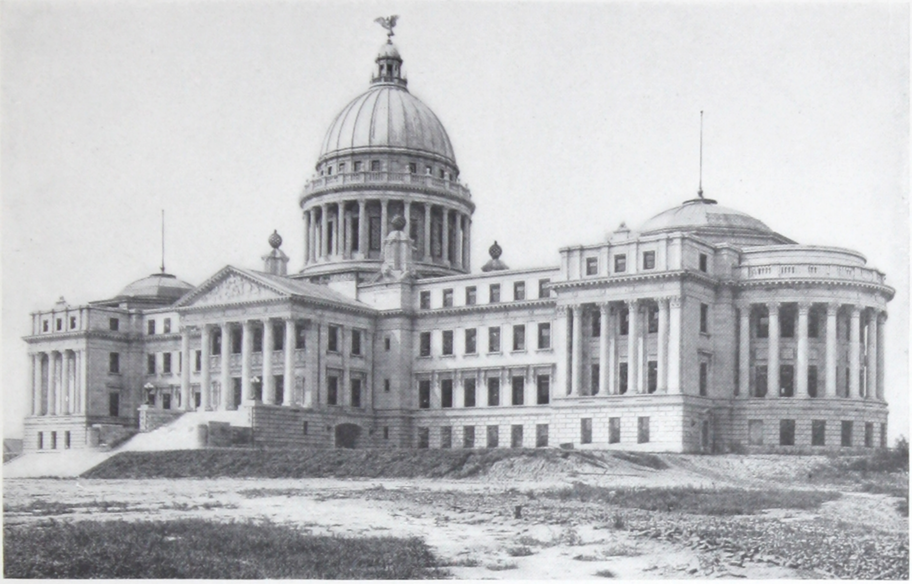
Andry & Bendernagel, Architects McNally & Mullaney, Contractors

Universal Portland Cement used

Denechaud Hotel, New Orleans

Toledano & Wogan, Architects — Milliken Brothers, Contractors

Universal Portland Cement used — 4000 barrels



Mississippi Capitol, Jackson, Miss.
T. C. Link, Architect — Wells Bros. Co., Contractors

Plaza Hotel, Minneapolis, Minn.
Keith Company, Architects — C. F. Haglin, Contractor
Universal Portland Cement used — 5000 barrels

Security Bank Building, Minneapolis, Minn.

Long & Long, Architects

C. F. Haglin, Contractor

Our Northwestern Sales Office is in this building

Universal Portland Cement used exclusively—22,000 barrels

Jefferson Hotel, St. Louis

Barnett, Haynes & Barnett, Architects — Roebling Construction Co., Contractors

Universal Portland Cement used exclusively in concrete fireproofing — Roebling system — 6000 barrels

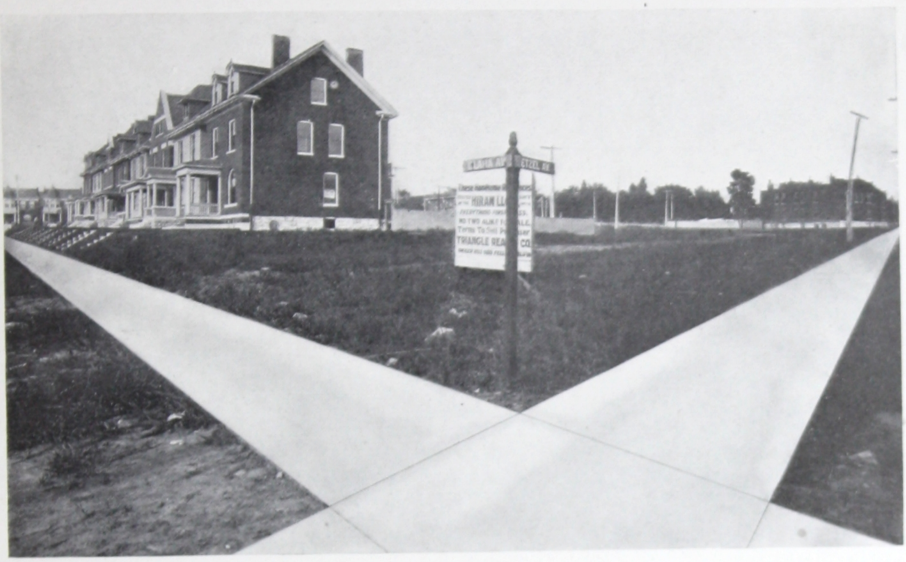
Third Street, Janesville, Wisconsin, Curb and Gutter

Northwestern Tile Co., Contractors, Milwaukee

Seventy-second Street and Euclid Avenue, Chicago

Illinois Portland Cement Paving Co., Contractors

Universal Portland Cement used



Clara and Etzel Avenues, St. Louis

R. E. McMath Surveying Co., Engineers, St. Louis — Zbaren Construction Co., Contractors, St. Louis

Universal Portland Cement used

Kingshighway and Laclede Avenue, St. Louis

P. M. Bruner Granitoid Co., Contractors

Universal Portland Cement used

Main Dam of Great Northern Power Comp

National Railway Construction Compan

THOS PETTIGREW, CHIEF ENGINEER

The National Railway Construction Co.

CONSTRUCTING GREAT NORTHERN POWER COMPANY'S HYDRO-ELECTRIC DEVELOPMENT

316 PROVIDENCE BLDG. ZENITH PHONE 206. BELL PHONE 626.

HOME OFFICE 53 STATE STREET, BOSTON MASS

DULUTH, MINN October 29,1906

Universal Portland Cement Company,
Chicago, Illinois.

Gentlemen:-

The main service reservoir of the Great Northern Power Company's development, is situated near Thomson, Minnesota, at the head of the rapids of the St.Louis River. It is a lake of nearly 500 acres, which has been made by the construction of about 12 dams, 2 of which are earth, 1 of rock-filling, with a central core wall, and the remainder of concrete. The main dam across the river proper is about 1200 feet long of which 365 feet is spillway section and the balance retaining section. Photograph #230 herewith, shows the spillway of this dam, and also the sluice-gates section for lowering the water in the reservoir when necessary.

The total amount of concrete in these dams, and in the head gates at the entrance of the Canal, is 27300 cubic yards, 20000 of which are in the river section just referred to. Universal Portland cement was used entirely through this structure at an average rate of about 1-1/2 barrels to the cubic yard of concrete. About 15000 yards of this concrete was laid between the 1st of November, 1905 and the 20th of March, 1906, during the cold winter weather of this latitude and under conditions which were oftentimes difficult. We cannot notice any difference between the concrete set in the winter and that set in the summer, and have always found your cement to be first class under all conditions of use. In all, we have used about 65000 barrels of your cement, in dams, gate houses, powerhouses, and pipe lines, all of which was thoroughly and carefully tested and in no case have we ever found an unsatisfactory barrel.

I can certainly congratulate you on the excellence, and the remarkable uniformity of your product.

Very truly yours,

Thos Pettigrew

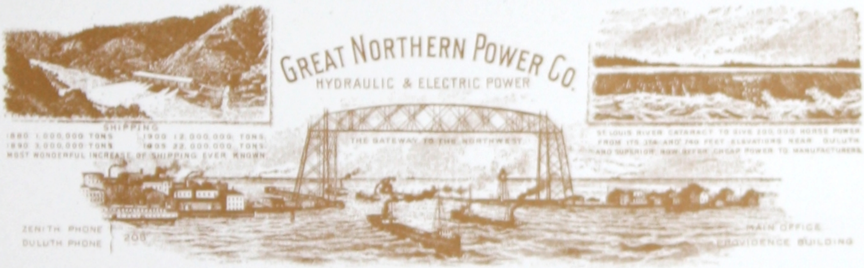
Chief Engineer.

DIC.TP

mpany Across St. Louis River near Duluth

pany, Contractors (see description below)

C. A. DUNCAN, PRESIDENT H. P. BROUGHTON, GENERAL MANAGER F. A. COKEFAIR, CHIEF ENGINEER



ZENITH PHONE
DULUTH PHONE

MAIN OFFICE
PROVIDENCE BUILDING

DULUTH, Minn., Oct. 27, 1906.

Universal Portland Cement Company,

Chicago, Ill.

Gentlemen:-

Replying to your request of Oct.26th, I write to say that something over 60,000 barrels of Universal Portland Cement were used during the last eighteen months in the construction work of the Great Northern Power Company, including dams, retaining walls, head-gates, power house foundations, etc. Careful tests were made of all this cement in our laboratory, all of which conformed to our rather rigid specifications.

The results as shown in our work are very satisfactory and we have confidence in your product for any important work.

Yours very truly,

Great Northern Power Company.

Dic.FAC-M

By F. A. Cokefair
Chief Engineer.

Shelter House in McKinley Park, Chicago
Universal Portland Cement used exclusively in walks, artificial stone, etc.

Sidewalks and Curbing, St. Paul, Minn.
Universal Portland Cement used

Sidewalks and Curbing, Loring Park, Minneapolis, Minn.
Universal Portland Cement used

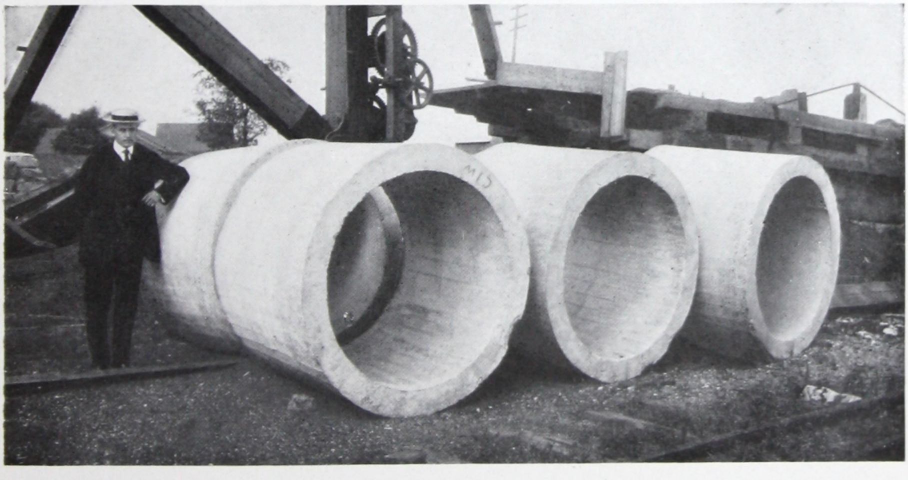
Sidewalk, State and Taylor Streets, Chicago
Universal Portland Cement used

Artificial Curbing made by C. M. & St. P. R. R.
Universal Portland Cement used

Reinforced Concrete Subway on Vandalia R. R., near Indianapolis

F. T. Hatch, Chief Engineer, Vandalia R. R. Co. Essex Construction Company, Contractors

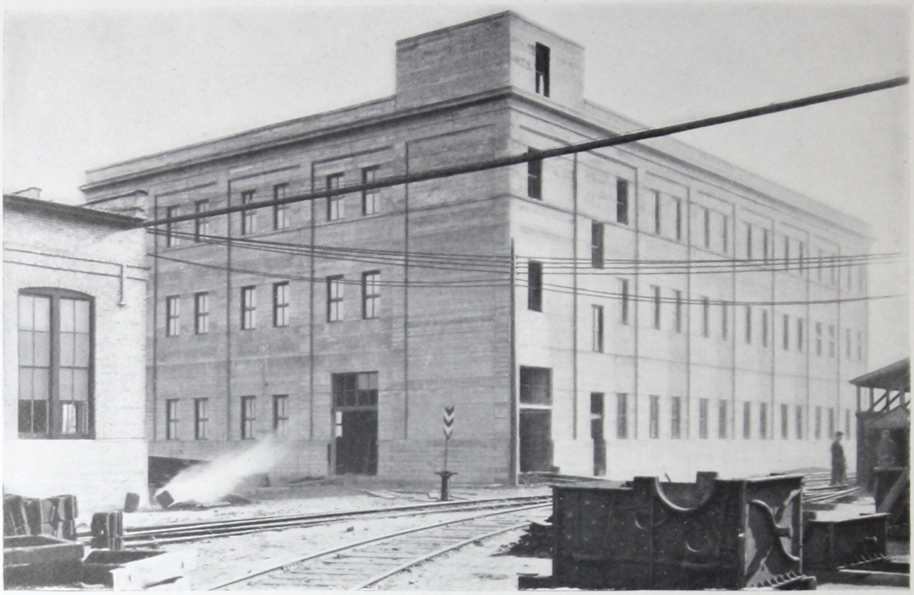
Universal Portland Cement used exclusively



Concrete Culvert Pipe for Chicago and Illinois Western Railroad

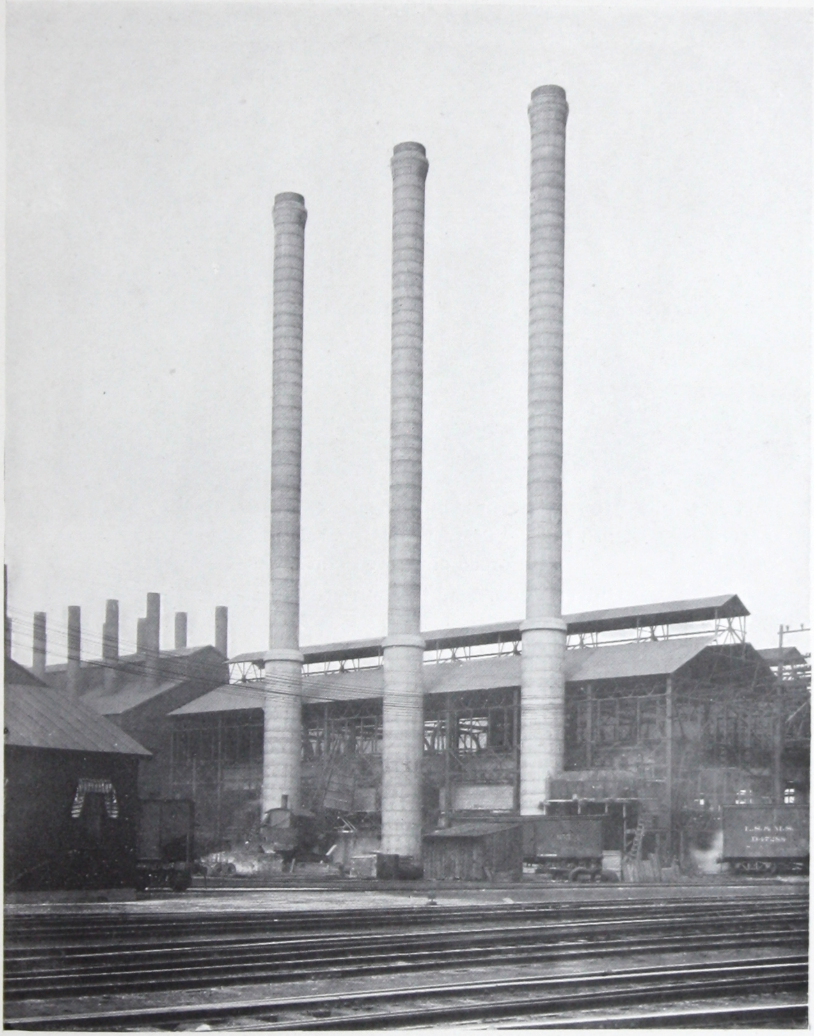
O. P. Chamberlain, Chief Engineer

Universal Portland Cement used exclusively



Pattern Shop C. M. & St. P. R. R., Milwaukee, Wis.
Reinforced Concrete Throughout. Universal Portland Cement used

Interior Pattern Shop C. M. & St. P. R. R., Milwaukee, Wis.
Reinforced Concrete Floors, Columns and Beams. Universal Portland Cement used



Reinforced Concrete Smoke Stacks, South Chicago

Weber Steel Concrete Chimney Co., Contractors, Chicago

Universal Portland Cement used — 900 barrels

Sheffield Elevator Company Annex, Minneapolis, Minn.

H. N. Leighton Company, Engineers and Contractors

Reinforced concrete grain tanks

Universal Portland Cement used exclusively

Coal Pits, Western Electric Co., Chicago

F. E. Davidson, Architect E. C. & R. M. Shankland, Engineers R. S. Blome Co., Contractors

Universal Portland Cement used — 5000 barrels

Transformer Station, Sanitary District of Chicago

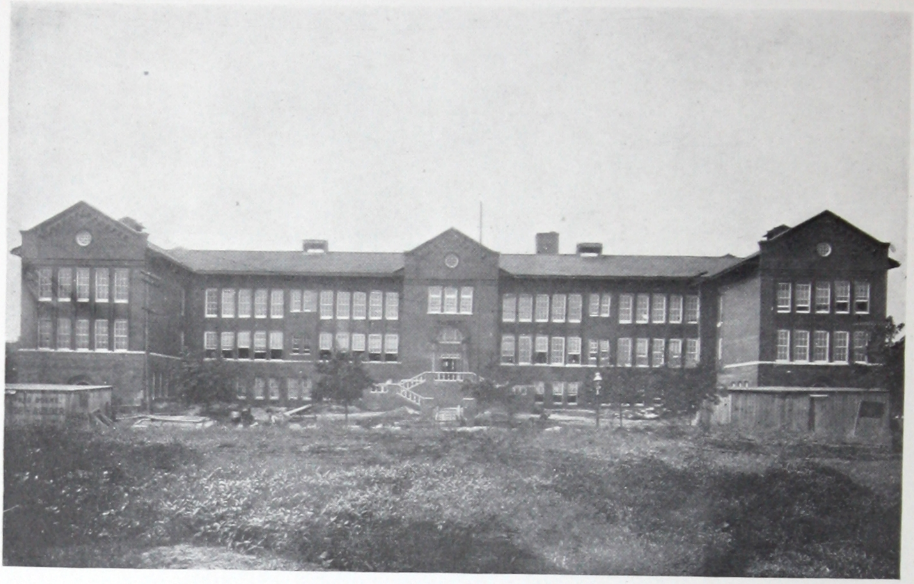
Isham Randolph, Chief Engineer — Geo. M. Wisner, Assistant Engineer
F. L. Barrett, Architect — Warren Construction Co., General Contractors

Western Avenue and drainage canal, Chicago. Concrete block construction throughout
Universal Portland Cement used exclusively—2800 barrels.

Stock Pavilion, Minnesota State Fair Grounds

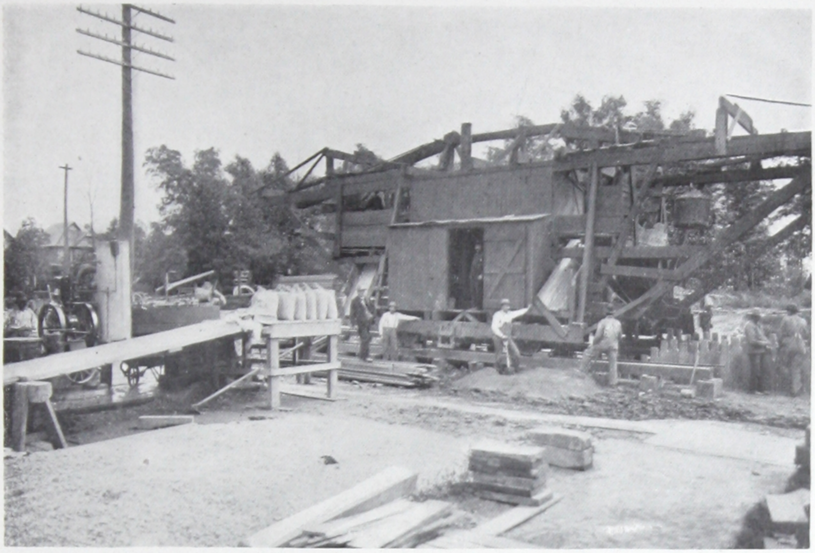
Wm. M. Kenyon, Architect — Pike & Cook, Contractors

Concrete foundations and floors, artificial stone sills, lintels and water-table, stucco on brick walls
Universal Portland Cement used exclusively



Franz Sigel School, St. Louis, Mo.
William B. Ittner, Architect, St. Louis, Mo.
Wm. R. Rush Construction Co., Contractors for Reinforced Concrete Fireproofing
Universal Portland Cement used exclusively — 2000 barrels

Residence Cavour S. Langdon, Minneapolis, Minn.
William Channing Whitney, Architect H. N. Leighton Company, Contractors
Universal Portland Cement used exclusively



View Showing Excavating Plant and Concrete Mixer in Operation

View Showing Concrete of Lower Half Completed
with centering and rods in place to receive concrete for upper half

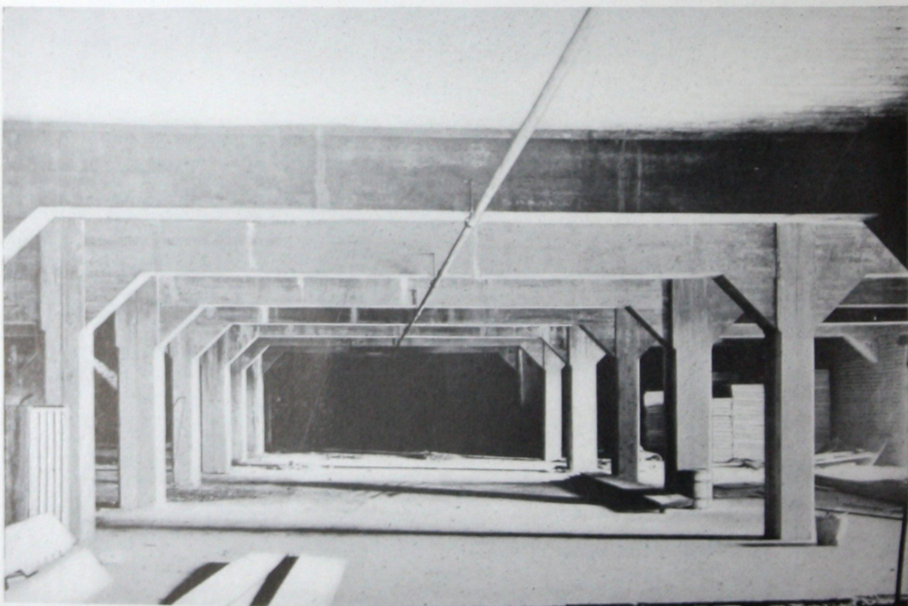
Reinforced concrete sewer construction, 26th Avenue, North, Minneapolis
Universal Portland Cement used

Northwestern Knitting Company Building, Minneapolis, Minn.

Bertrand & Chamberlin, Architects — John Wunder, Contractor

All interior construction of reinforced concrete

Universal Portland Cement used exclusively



La Crosse Can Company Building, La Crosse, Wis.

Graff & Derr Construction Co., Contractors

Reinforced concrete columns, girders and floors

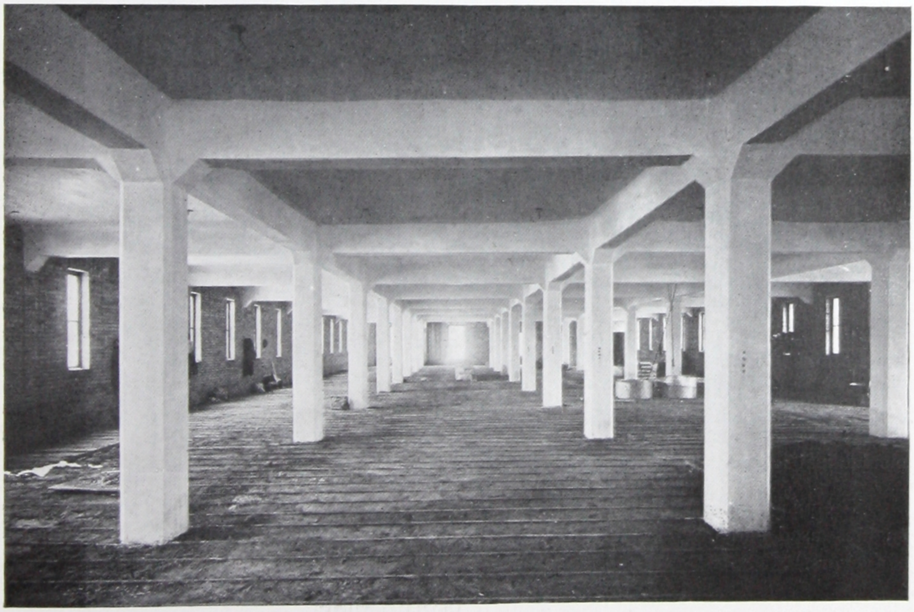
Universal Portland Cement used exclusively

Weyman & Bro., Factory Building, Chicago

Richard E. Schmidt, Garden & Martin, Architects and Engineers Paul F. P. Mueller, General Contractor

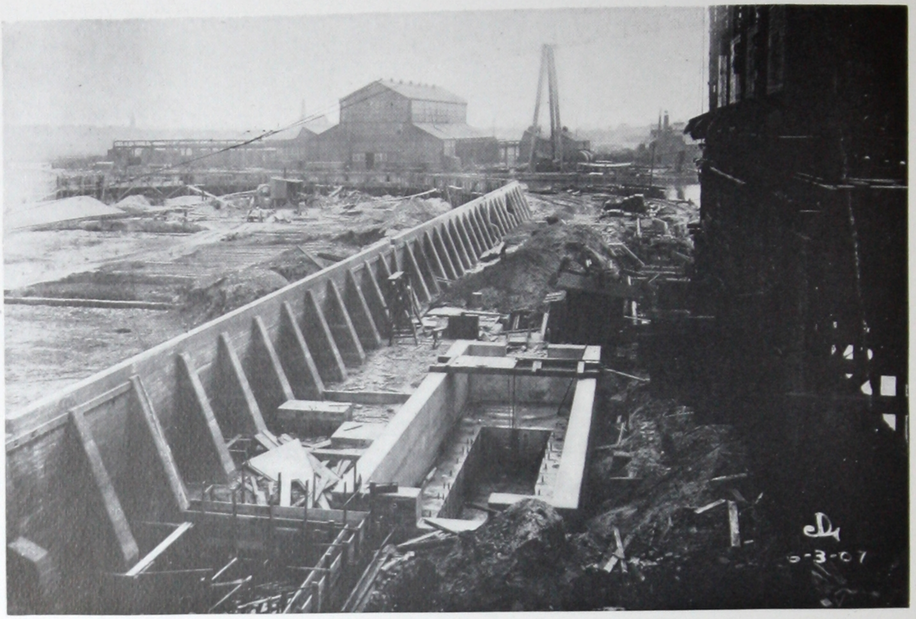
All interior construction of reinforced concrete

Universal Portland Cement used exclusively—8000 barrels



Northwestern Knitting Co. Warehouse, Minneapolis, Minn.

C. A. P. Turner, Engineer John Wunder, Contractor and Superintendent



Coal Dock for Lehigh Valley Coal Company, South Chicago

Witherspoon-Englar Co., Contractors

Universal Portland Cement used exclusively—7000 barrels

THIS coal dock is to replace dock destroyed by fire in November, 1906. The storage portion is contained in a single building, 501 feet long by 231 feet wide, covered by a roof supported by steel arches of 3-hinge type, 230 feet clear span, the whole enclosed by reinforced concrete bulkhead 15 feet above the level of the ground.

Coal is loaded from ships by means of five movable unloading towers operating on a trestle 314 feet in length along the slip. These unloading towers discharge the coal into a wharf conveyor running the entire length of the trestle and discharging into any one of four trimmer conveyors which transfer the coal to the storage building.

Coal is reloaded from the storage building by four reloader conveyors running in concrete tunnels and discharging into an inclined wharf conveyor carrying the coal to a screen house located at one end for repreparation.

From the screen house the coal is distributed to storage pockets discharging either direct into gondola cars or on a belt conveyor running from the screen house to a mechanical box car loader.

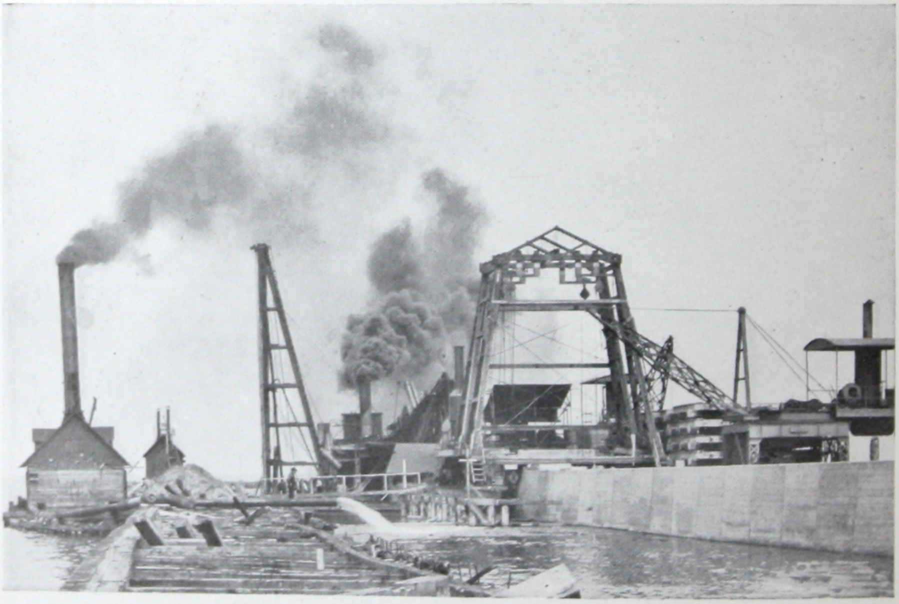
The plant is operated by steam generated in a central boiler plant, piped to the various engines used and being delivered from the engines by rope transmission to the various conveyors.

A prominent feature of this plant is that **no timber** enters into the construction of the building used for storage of the coal, the same being constructed entirely of **reinforced concrete and steel** and the whole supported on pile foundation.

Government Lighthouse, Racine, Wisconsin

Great Lakes Dredge and Dock Co., Contractors, Chicago

Universal Portland Cement used — 2600 barrels



Concrete Piers, Superior Entry, Wis.

(See description opposite)

Universal Portland Cement used exclusively

Concrete Piers, Superior Entry, Wis., Duluth-Superior Harbor, Lake Superior

The following description of this work was furnished to explain model on exhibition in Government Building at World's Fair, St. Louis. Note that concrete in substructure was deposited directly in water in monoliths containing from 75 to 458 cubic yards.

The canal as now being rebuilt is 3220 feet long, 300 feet wide and 23 feet deep. Length of north pier, 3430 feet; south pier, 3010 feet. The canal connects Lake Superior with the southerly portion of Duluth-Superior harbor. It is at the site of the original natural entrance. Originally built with timber piers in 1867-75. Reconstruction with concrete piers commenced in 1903, and now in progress. Estimated cost of reconstruction, $925,000.00.

FOUNDATION — Trench dredged to a depth of 21 feet. Bearing piles penetrating sand to a depth of 16 feet by means of hammer and water jet. The piles are sawed off 18 feet below low water, and 3 feet above bottom of trench. Average load per pile in largest section, 33 tons.

SUBSTRUCTURE — Concrete built in place in removable subaqueous molds, as shown in model. Alternate or "isolated" blocks are first built each 16 feet long and with spaces of 16 feet left vacant for the intermediate blocks. Mold for an isolated block consists of four sides. It is assembled complete on land and transported and placed in position by means of a large traveler. Mold for an intermediate block consists of two sides, which are clamped to the adjoining isolated blocks (previously built) by means of a special device. It is believed that the assistance of a diver will not be necessary in placing or removing the subaqueous molds, special devices having been designed for performing this work from above the water.

The concrete is deposited by means of a specially designed bucket, handled by a traveling derrick.

Number of yards of concrete in each subaqueous monolithic block in the several sections is 75.5, 148.3, 194.4 and 458.4, respectively.

SUPERSTRUCTURE — Concrete built in place, in removable molds, superimposed on the superstructure. Mostly above water. A gallery is built in the lake sections, making a passage to the pier-head and light house during storms.

About 94,000 yards of concrete will be used in the entire work.

Designed by Captain D. D. Gaillard, Corps of Engineers.

Now being built under direction of Captain Chas. L. Potter,* Corps of Engineers, officer in charge, succeeding Captain Gaillard; Clarence Coleman, M. Am. Soc. C. E., assistant engineer in charge.

* Since succeeded by Major Graham D. Fitch.

Concrete Blocks, North Pier, Chicago Harbor

Lieutenant-Colonel W. H. Bixby, U. S. A., Engineer Corps G. A. M. Liljencrantz, Assistant Engineer
Great Lakes Dredge & Dock Co., Contractors

Full description is given in *Rock Products* September 23, 1907, from which we quote as follows:

The task undertaken by the contractors was to remove a damaged part of the old cribbing and to replace it with new work; to repair the whole submarine structure in such a way as to produce a perfect job; to construct a concrete foundation at the water line with a superstructure of sufficient height and strength to shelter the harbor entrance completely, and to provide a passageway for reaching the light at the eastern extremity of the pier in the shape of a continuous tunnel. Thus the pier, when completed, will consist of heavy timber cribbing filled with rubble stone under water, and the entire length of 1000 feet will be capped with heavy concrete masonry at the water line upon which an arch as long as the pier will be constructed, the height of which will be about ten feet above the water line, and probably higher than the wash of even the fiercest storm.

* * * * * *

The part of the undertaking in which we are most deeply interested consists of three distinct operations:

First, the manufacture and placing in position of two courses of heavy concrete foundation blocks, one row on each side of the pier, about twenty-six feet apart and fastened together by means of tie-rods, in such a way as to form two continuous foundations of the concrete blocks, each resting upon the outer edges of the cribbing.

Second, the filling of the space between these two rows of foundation blocks with mass concrete, dressing the concrete floor level with the top of the foundation blocks, which is about two feet above the water line, and thus practically making this entire water line foundation monolithic in character, for the opposite blocks are tied together by means of tie-rods imbedded in the mass concrete, while between every pair of blocks as set in the foundation is provided a tongue of concrete, which is also a part of the mass joining the two rows of the blocks.

Third, the concrete superstructure, which will consist of side walls and roof built of concrete molded in mass so as to form a continuous arch resting on channels provided in the two side rows and two end walls of foundation blocks, and leaving the walls and roof of the superstructure a passageway, the floor of which is the top surface of the concrete joining the two side rows of foundation blocks.

* * * * * *

The concrete foundation blocks are cast in wooden molds made of heavy timbers and rigidly bolted together so as to give the prescribed shape as shown in the illustration. Each block measures 9 feet for the longest dimension, by 5 feet in width, and perpendicularly 3 feet. They weigh approximately 10 tons each. The outer water face of each block presents a one-foot perpendicular rise and beveled wash of two feet. The opposite or inside end of the block is provided with iron staples molded into the concrete for the purpose of attaching the tie-rods, which are provided with turn-buckles so that the exact distance between the blocks can be finally regulated by the screws.

* * * * * *

The blocks are made of one-to-five concrete, Universal Portland Cement being used, and crushed rock (2½-inch ring size), with all of the crushed product retained as it comes with the run of the crusher. The crushed rock is delivered in 500-ton barges from the Western Stone Company's crushing plant at Lemont, Ill., located on the drainage canal, the barges of crushed stone being towed right up alongside the work. Sand is also delivered in barges the same way, and the contractors have provided a derrick boat, equipped with a clamshell bucket, to rapidly handle large quantities of material.

Concrete slush is forced into the molds, firmly tamped and then kept under wet burlap for a period of ten or twelve days. Each block is inspected and accepted by the Government's engineer before it can be passed on the work. Forty blocks are made at one casting, or enough for 100 feet of pier foundation. While a new set of blocks are being made in this way, those last completed are placed in their final position by the use of the derrick boat and tug.

The economy of concrete foundation stone of this character is enormous as compared with the quarrying, transporting, cutting and fastening of iron anchorage in natural stone. It is with greatest facility that the materials can be assembled anywhere for making such stone in this artificial manner, contributing both speed and economy to the work. At the same time this artificial material is superior to any natural stone obtainable. Indeed, the number of quarries that could furnish at any price a large quantity of stone of such dimensions is limited, and quarries having such stone are practically inaccessible at points where heavy pier construction is most needed. Four hundred and sixty of these foundation blocks are required in the reconstruction of the north pier.

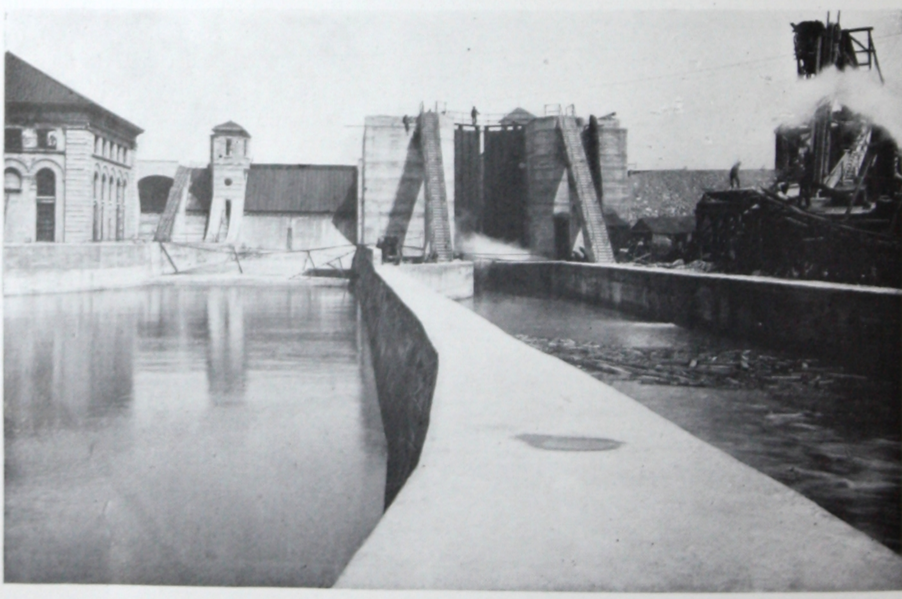
* * * * * *

The mixer provided by the Great Lakes Dredge and Dock Company is a unique arrangement and can be described as follows: A barge is provided with a platform on rollers and a pivot, so that the platform constitutes a turntable, and upon this platform a

framework is provided with a cylinder about twenty-four inches in diameter and six feet long. Hoppers are provided at the elevated end of the cylinder for the purpose of feeding in cement, crushed rock and sand in their proper proportions. Stationary paddles or plows inside of the cylinder accomplish the thorough mixing of the materials as the cylinder with its contents revolves (ten revolutions per minute). From the lower or discharge end of the cylinder the semi-wet concrete mass is delivered by means of a chute directly into the section where the work is in progress. Laborers spread the discharged concrete over the section as fast as it is discharged. The mixer is operated by power from a steam engine stationary upon the deck of the same barge with the mixer attachments to allow its complete revolution upon the turntable. The enormous capacity of this mixer can better be appreciated when it is explained that each one of the sections mentioned contains approximately seventy cubic yards and such a section is filled with concrete leveled and troweled off in less than one hour — the actual work of the mixer being less than thirty minutes. The mixer is moved from section to section as the work progresses.

* * * * * *

The side walls of the superstructure are to be built in place, of concrete in mass, resting in the channels of the foundation blocks, and will be built over a form in sections of twenty-five feet, reaching a total elevation of eight feet nine inches, each pair of wall sections to be tied together by one-inch iron rods, two to each pair of opposite blocks. Opposite sections of side walls will be built simultaneously, and at every four feet of length a T-rail reinforcement will be built into the wall horizontally so as to reinforce the concrete crowning roof, which will be built of mass concrete after the sections of side wall have set sufficiently.



Lock and Dam, Drainage Canal, Sanitary District of Chicago

Near Joliet, Illinois

(See description opposite)

Concrete Lock, Drainage Canal, Sanitary District of Chicago

Isham Randolph, Chief Engineer   Geo. M. Wisner, Assistant Chief Engineer   Hayes Bros. Co., Contractors
Design by L. E. Cooley

Universal Portland Cement used exclusively—13,000 barrels

THE lock and dam shown in the accompanying illustrations are located adjacent to the power house near Joliet, Illinois, where a fall of 34 feet is secured, developing 41,000 horse-power. The lock is 130 feet long and 22 feet wide with a lift of 34 feet, this being greater than the lift of any other lock in the world.

This lock is designed to accommodate only the traffic formerly passing through the old Illinois and Michigan Canal. Space has been reserved just south of this lock for a lock large enough to pass the largest lake steamers when the proposed deep waterway from the lakes to the gulf is undertaken.

United States Geological Survey, Reclamation Service Irrigation Projects in which Universal Portland Cement has been used

	Barrels
Wyoming	
Shoshone Dam, Shoshone Project	25000
Corbett Tunnel, Shoshone Project	20000
Montana	
Huntley Canal, Huntley Project	18000
Milk River Project	5000
Sun River Project	5000
Montana and North Dakota	
Lower Yellowstone Canal, Lower Yellowstone Project .	20000
Wyoming and Nebraska	
Interstate Canal, North Platte Project	5000
Pathfinder Dam, North Platte Project	15000
Idaho	
Payette Boise Project	10000
North Dakota	
Williston Pumping Plant, Buford-Trenton Project . .	5000
Total . . .	128000

Among the United States Engineer Officers who have used Universal Portland Cement are the following

	Barrels
Major Charles L. Potter, Duluth, Minn., pier at Superior entry to Duluth-Superior harbor	65000
Colonel E. H. Ruffner, Cincinnati, Ohio, locks on Big Sandy River	7500
Captain Charles S. Bromwell, New Orleans, La., artificial stone for revetment, Mississippi River	3000
Lieut.-Colonel R. L. Hoxie, St. Paul, Minn., Pokegama Dam, Minnesota	3500
Captain E. H. Schultz, St. Paul, Minn	5000
Lieut.-Colonel G. McC. Derby, St. Paul, Minn.	6250
Major J. G. Warren, Milwaukee, Wis., lighthouse, Racine, Wis.	2500
Lieut.-Colonel W. H. Bixby, Chicago, locks on Illinois and Mississippi Canal	1500
Lieut.-Colonel W. H. Bixby, Chicago, North Pier, Chicago River	6000

United States Post Offices where Universal Portland Cement has been or is now being used

Pekin, Ill.
DeKalb, Ill.
Evanston, Ill.
Ottawa, Ill.
Oak Park, Ill.
Jacksonville, Ill.
Decatur, Ill.
Anderson, Ind.
Crawfordsville, Ind.
Logansport, Ind.
Vincennes, Ind.
Atlantic, Iowa
Paducah, Ky.
Joplin, Mo.
Muskegon, Mich.
St. Paul, Minn.
Albert Lea, Minn.
Vicksburg, Miss.
Blair, Neb.
Findlay, Ohio.
Pierre, So. Dak.
Los Angeles, Cal.
Spokane, Wash.
Memphis, Tenn.
Fond du Lac, Wis.
Eau Claire, Wis.

Among the Railroads that have used Universal in all classes of work, amounting in some cases to 200,000 barrels, are the following

Alabama and Vicksburg
Atchison, Topeka and Santa Fa
Baltimore and Ohio
Chicago and Alton
Chicago and Eastern Illinois
Chicago and Northwestern
Chicago and Western Indiana
Chicago, Burlington and Quincy
Chicago Great Western
Chicago, Indiana and Southern
Chicago, Indianapolis and Louisville
Chicago Junction
Chicago, Milwaukee and St. Paul
Chicago, Rock Island and Pacific
Chicago, St. Paul, Minneapolis and Omaha
Chicago Southern
Chicago Terminal Transfer
Cleveland, Cincinnati, Chicago and St. Louis
Duluth and Iron Range
Duluth, Missabe and Northern
Erie
Evansville and Terre Haute
Grand Trunk
Great Northern
Illinois Central
Illinois Terminal
Illinois, Iowa and Minnesota
Indiana Harbor
Minneapolis, St. Paul and Sault Ste. Marie
Mississippi and Bonne Terre
New Orleans and Northeastern
New York, Chicago and St. Louis
Northern Pacific
Pittsburg, Cincinnati, Chicago and St. Louis
Pittsburg, Fort Wayne and Chicago
St. Louis and San Francisco
Terminal Railroad Association of St. Louis
Vandalia
Vicksburg, Shreveport and Pacific
Wabash
Wheeling and Lake Erie
Wisconsin Central
Wisconsin and Michigan
Yazoo and Mississippi Valley

Form B & B 109

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

BRIDGE AND BUILDING DEPT.

REPORT OF SPECIAL LONG TIME TEST OF CEMENT

CHICAGO, November 5" 1904

Six month TEST OF Universal CEMENT WAS MADE TODAY. RESULTS OF THIS TEST TO DATE ARE SHOWN BELOW

TEST NO.	SETTING INITIAL	SETTING FINAL	SPECIFIC GRAVITY	PER CENT. FINENESS No 50s	No 100s	No 200s	CONDITION OF PATS Cold Water	STEAM	BOILING
4031	3:45	7:00	3.11	---	97.5	80.3	O.K.	O.K.	----

PROPORTIONS	TENSILE STRENGTH IN LBS. PER SQUARE INCH: 1 DAY	7 DAYS	28 DAYS	3 MO	6 MO.	1 YR	2 YRS.	3 YRS.
NEAT CEMENT	296	600	726	816	757			
	282	654	779	750	787			
	297	602	792	741	734			
AVERAGES	292	619	766	769	759			
CEMENT AND SAND 1:3 BY VOLUME		224	284	387	408			
		204	342	391	454			
		230	286	394	390			
AVERAGES		219	304	391	417			
Averages, 1:3 by weight		310	414	535	542			

REMARKS

Sample taken from car #71900. At Bridge H.962

E. J. Guerman[?]
CEMENT TESTER.

UNIVERSAL PORTLAND CEMENT EXCELS IN SAND CARRYING CAPACITY

Tests of Universal Portland Cement

New Orleans City Testing Laboratory

FINENESS:	Residue on No. 100 sieve 1½ per cent. Residue on No. 200 sieve 22 per cent.		
SPECIFIC GRAVITY:	3.21		
SETTING TIME:	Initial 1 hour 35 minutes Hard 3 hours 55 minutes Temperature of air 30 degrees Centigrade		
	Time	Neat	Cement 1 Sand 3
TENSILE STRENGTH: In pounds per square inch	24 hours	316	
	7 days	650	207
	28 days	801	329
	3 months	813	332
	6 months	832	335
	1 year	850	345
	2 years	885	385
	3 years	915	389

Tensile tests are averages of 3 to 5 briquettes.
Water used in neat briquettes 21 per cent., in sand briquettes about 10 per cent.
Standard quartz sand used in sand briquettes.

Tests of Portland Cement

Minneapolis Testing Laboratory, 1905

Brand	Number of Barrels	Tensile Strain per Square Inch				Fineness		Time of Setting				Per Cent. Water Used	
		Neat		1 and 3		50	100	Initial		Hard			
		7 Days	30 Days	7 Days	30 Days	Mesh	Mesh	Hours	Minutes	Hours	Minutes	Neat	1-3
Universal	**41880**	**574**	**717**	**188**	**268**	**100**	**93**	**2**	**7**	**5**	**16**	**20**	**9^3**
Gibraltar	13490	705	782	218	283	100	92	1	57	5	29	20	9^3
Peerless	6845	797	876	234	312	100	92	1	55	5	52	20	9^3
Marquette	5850	653	748	192	242	100	92	2		5	11	20	9^3
Phœnix	1500	639^5	705	275	331	100	92^5	2	15	5	5	20	9^3
Dragon	1200	536	663	219	269	100	93	2	30	6	15	20	9^3
Chicago A A	1100	604	726	194	240	100	93	2	25	5	10	20	9^3
Alpha	600	755	795	288	355	100	94	1	40	4	55	20	9^3
Alpena	600	770	832	210	263	100	92^5	2		5	45	20	9^3
Wolverine	2600	754	796	251	315	100	92^5	1	57	5	10	20	9^3
Red Ring	1050	575	647	181	242	100	92	2	47	6	15	20	9^3
Elk Rapids	150	691	788	286	335	100	95	1	13	4	50	20	9^3
Great Northern	150	420	619	143	172	100	92	2		5	5	20	9^3
Iroquois	300	591^5	695	192	247	100	94	2	10	5	25	20	9^3

H. A. Gerdes, Inspector, January, 1906

Long Time Tests of Portland Cement

Minneapolis City Testing Laboratory, 1904

	Neat							One Cement—Three Sand						
	7 Days	30 Days	60 Days	90 Days	4 Mos.	6 Mos.	1 Yr.	7 Days	30 Days	60 Days	90 Days	4 Mos.	6 Mos.	1 Yr.
Universal	**504**	**589**	**559**	**607**	**626**	**671**	**755**	**190**	**213**	**233**	**251**	**293**	**314**	**315**
Chicago AA	543	634	705	721	730	695	833	171	246	266	284	343	289	295
Peerless	714	807	792	780	745	873	849	239	289	304	327	360	318	282
Alpena	652	727	749	721	672	627	728	206	285	260	271	306	341	270
Egyptian	585	603	689	700	710	681	792	231	313	302	307	335	338	312
Alpha	530	645	675	674	615	616	632	188	243	238	264	284	303	315
Owl	504	590	681	697	715	812	730	177	218	287	290	298	323	369
Dragon	537	642	601	610	620	629	652	232	252	304	318	320	317	307
Medusa	600	800	880	725	736	682	807	215	277	275	280	295	291	308
Wolverine	602	627	632	680	691	702	796	249	304	300	289	297	314	293
Pembina	239	244	202	260	299	293	328	95	127	164	176	210	242	278

The Baltimore and Ohio Railroad Company

Cement Laboratory

Sampled June 1, 1903, South Works
Universal Portland Cement

Test Started June 6, 1903
Lot No. U 1186

	Set				Per cent. of Water	Kind of Pat	Soundness and Tensile Test Results					
	Initial		Final				1 Day	7 Days	28 Days	3 Mos.	6 Mos.	1 Year
FINENESS: 98.5 per cent. through No. 100 Sieve	4	10	8	10	20	Boil	L					
	4	20	8	20		Boil	O K					
	4	00	8	00		Air		L	L	L	L	L
	4	20	8	20		Air		L	L	L	L	L
COLOR: Regular	4	10	8	00		Water		O K	O K	O K	L	L
	4	20	8	10		Water		O K	O K	O K	O K	O K
NEAT					20		338	521	735	700	620	900
							351	628	743	725	870	900
							359	654	786	815	875	915
							370	681	817	845	900	950
							374	698	881	855	925	
	Average						**358**	**636**	**790**	**788**	**888**	**916**
	Per cent. gain							74.8	24.2	0	12.6	3.1
3 TO 1					8			213	278	310	365	365
								216	283	345	370	390
								225	290	365	375	390
								238	304	380	400	415
								239	333	390	400	420
	Average							**226**	**298**	**358**	**382**	**396**
	Per cent. gain								31.8	20.1	6.7	3.6
5 TO 1					7			116	168	200	210	225
								119	183	205	220	240
								121	194	205	240	245
								127	194	215	245	245
								140	200	230	250	255
	Average							**125**	**189**	**211**	**233**	**242**
	Per cent. gain								51.2	11.6	10.4	3.8

NOTES—Temperature of water 18°, of air 18° to 20° Centigrade. L—Loosened from glass only.

A. W. Munsell, Cement Inspector
Wheeling, West Virginia

NEW YORK OFFICE
71 BROADWAY.

PITTSBURG OFFICE:
MONONGAHELA BANK BUILDING.

ROBERT W. HUNT & CO.

BUREAU OF INSPECTION, TESTS AND CONSULTATION,

GENERAL OFFICE: 1121 "THE ROOKERY" CHICAGO, ILL.

CHICAGO, June 21 1901.

Messrs. Jenney & Mundie, Architects,

519 New York Life Bldg., Chicago.

REPORT OF TESTS ON seventeen (17) samples OF Universal Portland CEMENT

SUBMITTED BY

INITIAL SET	HR	MIN	COLD WATER TEST O-K
FINAL SET	HR	MIN	BOILING TEST O-K.
PER CENT FINENESS ON	100 mesh		SIEVE 96.0

TENSILE TEST

INITIAL SET			NEAT			1 CEMENT	3 SAND	
NUMBER	HR	MIN	24 HR	7 DAY	28 DAY	24 HR	7 DAY	28 DAY
1	3	25	247#	624#		152#	443#	
2	3	23	350	646		162	350	
3	3	26	403	635		154	354	
4	3	24	317	672		148	407	
5	3	25	356	643		172	312	
6	3	28	376	607		187	347	
7	3	26	298	580		143	298	
8	3	26	380	632		134	412	
9	3	24	357	615		179	307	
10	3	30	427	642		157	397	
11	3	28	342	557		162	333	
12	3	30	383	607		173	327	
13	3	28	323	675		132	324	
14	3	29	305	606		123	404	
15	3	27	347	609		155	334	
16	3	25	340	630		138	275	
17	3	28	312	666		135	318	
AVERAGE								

SAMPLE TAKEN FROM B. & O. Car #58519, June 12, 1901.

FOR use on New National Life Building, Chicago.

REMARKS:

Robert W. Hunt & Co.

Long Time Series Test—Universal Portland Cement

Illinois Central Laboratory of Cement Tests

J. F. LINDGREN, Chief Cement Tester | R. E. GAUT, Engineer of Bridges

Sample from Plant No. 3, Buffington, Ind., August 10, 1905

BOILING TEST . . . . . . O. K.
FINENESS On No. 100 sieve, 96.5 per cent.
SETTING TIME . . . . . 4 hours

Tensile Strength per Square Inch

Age	Neat										Average
7 days	647	664	643	630	639	625	660	662	654	685	651
28 days	805	800	792	763	778	750	752	755	752	778	772
3 months	825	823	840	855	826	855	834	826	857	838	838
6 months	852	830	842	828	853	854	820	830	825	852	839
9 months	809	795	825	800	805	832	805	800	822	806	810
12 months	845	843	835	860	832	830	840	863	827	835	841

Age	Cement 1 Standard Sand 3										Average
7 days	196	218	160	175	175	186	192	203	226	192	192
28 days	314	307	297	297	315	310	324	315	338	328	314
3 months	376	363	362	349	370	353	382	341	362	345	360
6 months	415	380	402	367	367	382	406	400	416	375	391
9 months	417	393	404	391	405	400	415	396	412	401	403
12 months	414	394	410	397	411	388	407	394	405	404	402

Long Time Series Tests—Universal Portland Cement

By H. L. Bailey & Co.

Sample from Plant No. 3, Buffington, Ind., August 12, 1905

SOUNDNESS . . . . O. K.
SETTING TIME Initial, 2 hours 48 minutes; final, 5 hours 50 minutes
FINENESS On No. 100 sieve, 97.5 per cent.; on No. 200 sieve, 80.1 per cent.

Tensile Strength per Square Inch

Age	Neat					Average
24 hours	392	361	380	380	392	381
3 days	518	469	482	471	501	488
7 days	630	658	673	642	637	648
28 days	692	724	725	703	750	719
3 months	820	784	780	792	812	798
6 months	894	876	914	881	863	886
9 months	888	896	900	872	891	889
12 months	943	893	914	927	903	916

Age	Cement 1 Standard Sand 3					Average
3 days	182	180	187	201	210	192
7 days	276	284	259	267	282	274
28 days	393	408	391	402	379	395
3 months	462	442	450	436	471	452
6 months	526	533	551	487	518	523
9 months	536	514	541	547	533	534
12 months	565	572	558	563	547	561

Standard Specifications for Portland Cement

Adopted by the American Society for Testing Materials November 14, 1904

Adopted by the American Railway Engineering and Maintenance of Way Association
March 23, 1905

(These specifications have been very generally adopted as standard by the largest consumers of Portland cement, including railroads, municipalities, engineers and architects.)

All tests shall be made in accordance with the methods proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the society January 21, 1903, and amended January 20, 1904, with all subsequent amendments thereto.

Portland Cement

18.—DEFINITION. This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials to which no addition greater than 3 per cent. has been made subsequent to calcination.

Specific Gravity

19.—The specific gravity of the cement, thoroughly dried at 100 degrees Centigrade, shall be not less than 3.10.

Fineness

20.—It shall leave by weight a residue of not more than 8 per cent. on the No. 100, and not more than 25 per cent. on the No. 200 seive.

Time of Setting

21.—It shall not develop initial set in less than thirty minutes, nor hard set in less than one hour nor more than ten hours.

Tensile Strength

22.—The minimum requirements for tensile strength for briquettes one inch square in section shall be within the following

limits and shall show no retrogression in strength within the periods specified:*

Age	Strength
Neat Cement	
24 hours in moist air	150 to 200 pounds
7 days (1 day in moist air, 6 days in water)	450 to 550 pounds
28 days (1 day in moist air, 27 days in water)	550 to 650 pounds
One Part Cement, Three Parts Sand	
7 days (1 day in moist air, 6 days in water)	150 to 200 pounds
28 days (1 day in moist air, 27 days in water)	200 to 300 pounds

Constancy of Volume

23.—Pats of neat cement about three inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(*a*) A pat is then kept in air at normal temperature and observed at intervals for at least twenty-eight days.

(*b*) Another pat is kept in water maintained as near 70 degrees Fahrenheit as practicable and observed at intervals for at least twenty-eight days.

(*c*) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

24.—These pats, to satisfactorily pass the requirements, shall remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

Sulphuric Acid and Magnesia

25.—The cement shall not contain more than 1.75 per cent. of anhydrous sulphuric acid (SO_3), nor more than 4 per cent. of magnesia (MgO).

* For example, the minimum requirement for the twenty-four hour neat cement test should be some value within the limits of 150 and 200 pounds, and so on for each period stated.

Specifications for American Portland Cement

From Report of Board of Engineer Officers, U. S. A., on Testing Hydraulic Cements
(Second Edition)

Professional Papers No. 28

1.—The cement shall be an American Portland, dry and free from lumps. By a Portland cement is meant the product obtained from the heating or calcining up to incipient fusion of intimate mixtures, either natural or artificial, of argillaceous with calcareous substances, the calcined product to contain at least 1.7 times as much of lime, by weight, as of the materials which give the lime its hydraulic properties, and to be finely pulverized after said calcination, and thereafter additions or substitutions for the purpose only of regulating certain properties of technical importance to be allowable to not exceed 2 per cent. of the calcined product.

2.—The cement shall be put up in strong, sound barrels, well lined with paper, so as to be reasonably protected against moisture, or in stout cloth or canvas sacks. Each package shall be plainly labeled with the name of the brand and of the manufacturer. Any package broken or containing damaged cement may be rejected or accepted as a fractional package, at the option of the United States agent in local charge.

3.—Bidders will state the brand of cement which they propose to furnish. The right is reserved to reject a tender for any brand which has not established itself as a high-grade Portland cement and has not for three years or more given satisfaction in use under climatic or other conditions of exposure of at least equal severity to those of the work proposed.

4.—Tenders will be received only from manufacturers or their authorized agents.

(The following paragraph will be substituted for paragraphs 3 and 4 above when cement is to be furnished and placed by the contractor:

No cement will be allowed to be used except established brands of high-grade Portland cement which have been made by the same mill and in successful use under similar climatic conditions to those of the proposed work for at least three years.)

5.—The average weight per barrel shall not be less than 375 pounds net. Four sacks shall contain one barrel of cement. If the weight, as determined by test weighings, is found to be below 375 pounds per barrel, the cement may be rejected, or, at the option of the engineer officer in charge, the contractor may be required to supply, free of cost to the United States, an additional amount of cement equal to the shortage.

6.—Tests may be made of the fineness, specific gravity, soundness, time of setting, and tensile strength of the cement.

7.—Fineness. Ninety-two per cent. of the cement must pass through a sieve made of No. 40 wire, Stubb's gauge, having 10,000 openings per square inch.

8.—Specific Gravity. The specific gravity of the cement, as determined from a sample which has been carefully dried, shall be between 3.10 and 3.25.

9.—Soundness. To test the soundness of the cement, at least two pats of neat cement, as taken from the package, mixed for five minutes with about 20 per cent. of water by weight shall be made on glass, each pat about three inches in diameter and one-half inch thick at the center, tapering thence to a thin edge. The pats are to be kept under a wet cloth until finally set, when one is to be placed in fresh water for twenty-eight days. The second pat will be placed in water which will be raised to the boiling point for six hours, then allowed to cool. Neither should show distortion or cracks. The boiling test may or may not reject at the option of the engineer officer in charge.

10.—Time of Setting. The cement shall not acquire its initial set in less than forty-five minutes and must have acquired its final set in ten hours.

(The following paragraph will be substituted for the above in case a quick-setting cement is desired:

The cement shall not acquire its initial set in less than twenty nor more than thirty minutes, and must have acquired its final set in not less than forty-five minutes nor in more than two and one-half hours.)

The pats made to test the soundness may be used in determining the time of setting. The cement is considered to have acquired its initial set when the pat will bear, without being appreciably indented, a wire one-twelfth inch in diameter loaded to weigh one-fourth pound. The final set has been acquired when the pat will bear, without being appreciably indented, a wire one twenty-fourth inch in diameter loaded to weigh one pound.

11.—Tensile Strength. Briquettes made of neat cement, after being kept in air for twenty-four hours under a wet cloth and the balance of the time in water, shall develop tensile strength per square inch as follows:

After seven days, 450 pounds; after twenty-eight days, 540 pounds.

Briquettes made of 1 part cement and 3 parts standard sand, by weight, shall develop tensile strength per square inch as follows:

After seven days, 140 pounds; after twenty-eight days, 220 pounds.

(In case quick-setting cement is desired, the following tensile strength shall be substituted for the above:

Neat briquettes: After seven days, 400 pounds; after twenty-eight days, 480 pounds.

Briquettes of 1 part cement to 3 parts standard sand: After seven days, 120 pounds; after twenty-eight days, 180 pounds.)

12.—The highest result from each set of briquettes made at any one time is to be considered the governing test. Any cement not showing an increase of strength in the twenty-eight-day tests over the seven-day tests will be rejected.

13.—When making briquettes well-dried cement and sand will be used; neat cement will be mixed with 20 per cent. of water by weight, and sand and cement with 12½ per cent. of water by weight. After being thoroughly mixed and worked for five minutes, the cement or mortar will be placed in the briquette mold in four equal layers, and each layer rammed and compressed by thirty blows of a soft brass or copper rammer three-quarters of an inch in diameter (or seven-tenths of an inch square, with rounded corners), weighing 1 pound. It is to be allowed to drop on the mixture from a height of about half an inch. When the ramming has been completed, the surplus cement shall be struck off and the final layer smoothed with a trowel held almost horizontal and drawn back with sufficient pressure to make its edge follow the surface of the mold.

14.—The above are to be considered the minimum requirements. Unless a cement has been recently used on work under this office, bidders will deliver a sample barrel for test before the opening of bids. If this sample shows higher tests than those given above, the average of tests made on subsequent shipments must come up to those found with the sample.

15.—A cement may be rejected in case it fails to meet any of the above requirements. An agent of the contractor may be present at the making of the tests, or, in case of the failure of any of them, they may be repeated in his presence. If the contractor so desires, the engineer officer in charge may, if he deem it to the interest of the United States, have any or all of the tests made or repeated at some recognized standard testing laboratory in the manner herein specified. All expenses of such tests to be paid by the contractor. All such tests shall be made on samples furnished by the engineer officer from cement actually delivered to him.

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